Multiplexing

1. Fill in the missing blanks.

There are two methods of multiplexing. They are **Frequency** Division Multiplexing and **Time** Division Multiplexing.

Multiplexing allows **many low** speed lines to **share/use** one high speed line.

In **FDM**, the available bandwidth is split into channels. A gap is left between adjacent channels. This gap is called the **guard band** .

TDM has no **flow** control and no **error** control.

2. A voice signal is allocated a bandwidth of 4kHz which covers the voice signal and the guard band. This channel in multiplexed by modulating a carrier frequency of 68kHz. What frequencies does the channel now occupy?

A voice signal is a baseband which means it starts at 0Hz. Therefore f_{LOWER} = 0Hz. To find the lower frequency after modulation $f_{LOWER\ (MOD)}$, the carrier frequency is added to f_{LOWER}.

$f_{LOWER\ (MOD)} = f_{LOWER} + f_{CARRIER}$ = 0Hz + 68 kHz = 68khz.

Since we are given the bandwidth, we can find the upper frequency $f_{UPPER\ (MOD)}$ by;

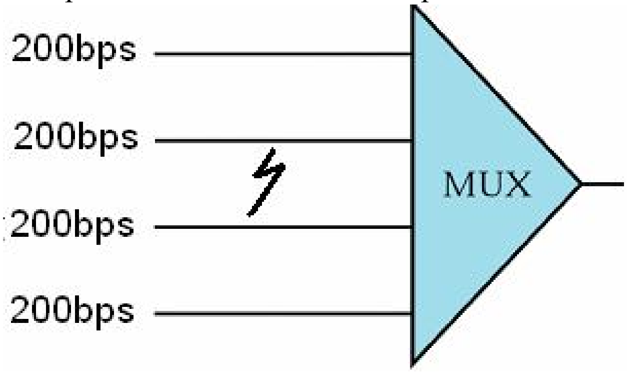
Bandwidth = $f_{UPPER(MOD)} - f_{LOWER(MOD)}$ -> $f_{UPPER(MOD)} = BW + f_{LOWER(MOD)}$
= 4kHz + 68kHz
= 72kHz .

3. What is the main advantage of a statistical multiplexer compared with synchronous multiplexing?

Synchronous multiplexing guarantees slots are available for every channel. However this can be wasteful if all the inputs to a multiplexer are not sending continuosly at their defined data rate. This leads to empty slots in the frames transmitted by the mux.

Statistical multiplexers take advantage of this by skipping over channels that are not sending data at the time and allocating the slots the channels that are. Since they do not have to send empty slots, they are able to operate at slower line speeds at the mux output. Alternatively they are able to provide service to more input channels given the same output data rate as a synchronous mux.

4. At an oil refinery, sensors in a remote part of the plant generate a steady stream of data at a rate of 200bps. There are 20 sensors in operation.



a) Each frame sent by the mux provides a 5 bit data slot for every sensor. If no data is to be lost, what must the frame rate be?
b) Each frame has a 5 bit data slot for every sensor and two synchonising bits. How many bits are in each frame?
c) What is the data rate at the output of the mux?

a). For a given channel, 200 bits must be transmitted each second. Each frame carries 5 bits. So the number of frame required to send 200 bits is;

No of frames (for 200 bits) = 200 / 5 = 40 frames.

Since 40 frames must be sent every second to maintain an input speed of 200 bps then the frame rate is 40 frames per second.

b). Each frame is made up of data bits and sync bits. There are 20 x 5 = 100 data bits and 2 sync bits (given). The total number of bits per frame is 102 bits.

c) The data rate at the output is the number of bits sent divided by the time to send it.

Rate $= \frac{bits}{time} = \frac{(40x102)}{1}$ **= 4080 bps.**

5. Explain how the term hierarchy applies to the multiplexing?

Where demand for capacity is high, the output of several muxes can be used as inputs to a higher order mux. The output of muxes at this level can be used as inputs to yet higher order muxes.

This cascade of multiplexers at the transmitting site needs to be reproduced in reverse at the receiving end.